



(RESEARCH ARTICLE)



INHIBITORY EFFICACY OF THE HYDROALCOHOLIC EXTRACT OF *FICUS ITEOPHYLLA* MIQ. (MORACEAE) LEAVES AGAINST CLINICAL STRAINS OF MULTIDRUG-RESISTANT *PSEUDOMONAS*

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ABSTRACT

Pseudomonas aeruginosa is a bacterium that poses major problems in hospital settings. Recent scientific research has shown the emergence of highly resistant strains particularly to carbapenems leading the WHO to classify this pathogen as a critical priority threatening human health. This study aims to evaluate the antibacterial effects of an 80% methanolic extract of *Ficus iteophylla* Miq. (Moraceae) leaves against 11 *P. aeruginosa* strains with different phenotypes and one reference strain, using agar well diffusion and broth macro-dilution methods. Thin-layer chromatography (TLC) was used to characterize the chemical compounds. The extract demonstrated varying levels of activity against the strains. It inhibited bacterial growth, producing inhibition zone diameters ranging from 18 ± 1.4 mm to 13 ± 2.0 mm. The largest zone (18 ± 1.4 mm) was observed with *P. aeruginosa* 795C, an imipenem-resistant strain (due to a porin D2 deficiency) isolated from the pus of a patient with a genital superinfection. The extract exhibited a bactericidal effect against 41.66% of the strains, with MIC values ranging from 0.625 to 1.25 mg/mL ; MBC values ranged from 2.5 to 10 mg/mL. Phytochemical screening revealed the presence of saponins, tannins, flavonoids, polyterpenes, anthocyanins, and polyphenols compounds beneficial in the management of *Pseudomonas* infections. This work contributes to the fight against bacterial resistance and justifies the current traditional use of *F. iteophylla*.

Keywords: *F. Iteophylla*, Antibacterial Activity, *P. Aeruginosa*, Phytoconstituents, Côte D'ivoire.

1 INTRODUCTION

Amidst the global crisis of antimicrobial resistance, *Pseudomonas aeruginosa* stands out as one of the most formidable pathogens in modern medicine. This opportunistic bacterium is characterized by exceptional genetic plasticity, conferring both natural and acquired resistance to conventional antibiotics ^[1]. In Côte d'Ivoire, the emergence of imipenem-resistant *P. aeruginosa* strains notably due to porin D2 deficiency perfectly illustrates this therapeutic impasse. This phenomenon is not isolated ; it is part of an alarming trend of accelerating bacterial mutations, which includes the proliferation of extended-spectrum beta-lactamase-producing Enterobacteriaceae (ESBL-E) and multidrug-resistant *Staphylococcus aureus* strains. National figures reflect the urgency of the situation : the overall

bacterial resistance rate rose from 5.3% in 2005 to 24.6% in 2012 [2]. This vulnerability to mutant bacteria serves as a reminder that infectious diseases remain the leading cause of death worldwide (Institut Pasteur, 2014), with bacteria implicated in 70% of these fatalities [3]. The situation in Côte d'Ivoire is particularly critical, as bacterial infections such as pneumonia and diarrheal diseases claim the lives of 20% and 15% of children under the age of five, respectively, while accounting for 16% of total mortality [4].

Faced with this health threat and the diminishing efficacy of synthetic drugs, scientific research must urgently explore new therapeutic avenues. Medicinal plants, which serve as the primary source of healthcare for over 80% of the Ivorian population [5], represent an inexhaustible reservoir of bioactive substances. Within this biodiversity, *Ficus iteophylla* Miq. (Moraceae) holds a prominent place in the African traditional pharmacopoeia. Known for treating a wide range of conditions from respiratory ailments (cough, bronchitis) to systemic disorders (wounds, diarrhea, jaundice) [6]. This plant is specifically used to combat suspected *Pseudomonas* infections. This study aims to scientifically validate this empirical use by evaluating the antibacterial activity of an 80% (v/v) methanolic extract of *Ficus iteophylla* Miq. (Moraceae) leaves against clinical strains of multidrug-resistant *Pseudomonas*, while also characterizing the profiles of the bioactive compounds responsible for this activity through qualitative analysis.

2 MATERIAL AND METHODS

2.1 Bacterial strains

The bacterial material was obtained from the bacterial strain biobank at the Institut Pasteur de Côte d'Ivoire specifically, from the Department of Bacteriology and Virology. These strains were previously collected at the Cocody and Yopougon University Hospitals (CHU) in Abidjan and consist of eleven (11) clinical strains, including three (3) wild-type strains, eight (8) imipenem-resistant strains, and a *Pseudomonas aeruginosa* reference strain (ATCC 27853) used for quality control (Table 1).

Table 1: List of different bacterial strains

Codes	Organic product	Resistance phenotype
891C	Pus	Imipenem resistance due to porin D2 deficiency
489C	Wound	Imipenem resistance due to porin D2 deficiency
261C	Urine	Imipenem resistance due to porin D2 deficiency
1076C	Urine	Imipenem resistance due to porin D2 deficiency
795C	Pus	Imipenem resistance due to porin D2 deficiency
792C	Ascites	Imipenem resistance due to porin D2 deficiency
1646C	Urine	Imipenem resistance due to porin D2 deficiency
956 C	Pus	Imipenem resistance due to porin D2 deficiency
955Y	Pus	Savage
565C	Pus	Savage
1016C	Pus	Savage
Reference strain		
ATCC 27853	<i>Pseudomonas aeruginosa</i>	

ATCC: American Type Collection Culture. Methods

2.2 Equipment used in the laboratory

The crude extract was obtained using a rotary evaporator, a freeze-dryer, vortex and magnetic stirrers, a Densimat, an oven, a fume hood, a refrigerator, automatic micropipettes (P200 and P1000), and a balance for weighing samples. A UV lamp, a chromatography tank, a digital camera, a hot plate, and various reagents were used to perform the phytochemical screening. The glassware and equipment used for the antibacterial assays included beakers (100 mL and 250 mL), test tubes, graduated cylinders, funnels, sterile Petri dishes (90 mm diameter), jars, Pasteur pipettes, hemolysis tubes, a stand, syringes (5 mL and 10 mL), sterile glass pipettes (10 mL), microfilters (0.22 µm and 0.45 µm), swabs, Whatman® 3 mm filter paper, aluminum foil, spatulas, latex gloves, masking tape, absorbent cotton, a timer, 100

and 1000 μL pipette tips, silica gel F₂₅₄ plates, microcapillary tubes, and rubber bulbs. Sterile distilled water, hexane, and 80% (v/v) methanol were the solvents used to prepare the extract.

2.3 Preparation of crude extracts

The leaves were harvested during the dry season in the savanna region of northern Côte d'Ivoire. Harvesting took place just before dusk, a time when the plants had had sufficient opportunity to secrete the active compounds needed to cope with the day's stressors. The samples were dried and then ground into a plant powder. The extraction method employed for this powder was based on the procedure described by [7], with some modifications. Specifically, 25 g of plant powder was macerated in 250 mL of hexane for 24 hours under magnetic stirring to defat the matrix. The residue remaining after hexane extraction was dried at room temperature (25–30°C) on blotting paper. It was then macerated in 250 mL of 80% methanol (200 mL of methanol mixed with 50 mL of water) for 24 hours under magnetic stirring (Stuart Scientific model). The mixture was vacuum-filtered twice using a Büchner funnel and Whatman® 3 mm filter paper. The filtrate was concentrated at 40°C using a rotary evaporator (Buchi Waterbath B-480 model) and subsequently freeze-dried at -70°C in a lyophilizer (Christ® Alpha 1-2 model) to yield the 80% methanolic extract, which was then packaged in a sterile glass vial and stored in a refrigerator.

2.4 Conducting antibacterial tests

2.4.1 Preparation of the inoculum for solid medium tests

The inoculum was prepared by emulsifying 24-hour-old cultures in 2 mL of 0.85% NaCl suspension. The optical density was adjusted to a 0.5 McFarland standard using a densitometer. A 1 mL volume was then diluted in 10 mL of physiological saline (0.9% NaCl), yielding a bacterial inoculum estimated at 10^6 bacteria/mL.

2.4.2 Tests of microbial sensitivity to extracts

A sterility test was first conducted to check the extract for microbial contamination. Antibiotic susceptibility testing was performed using the agar well diffusion method and the broth macro-dilution method [8]. Petri dishes containing Mueller-Hinton agar (MHA) were inoculated with the bacterial suspension using a swab. Fifty microliters of extract solution (prepared at 50 mg/mL) were dispensed into wells cut into the agar [9]. The plates were incubated at 37°C for 24 hours. Following incubation, the inhibition zone diameter around each well was measured using a caliper (**Figure 1**). The efficacy of the extract was evaluated based on the criteria established by [10]. According to these authors, a substance is considered ineffective if the inhibition zone diameter (IZD) is less than 8 mm, whereas it is considered effective if the IZD is between 9 and 14 mm. It is deemed highly effective if the IZD is between 15 and 19 mm, and extremely effective if it exceeds 20 mm.

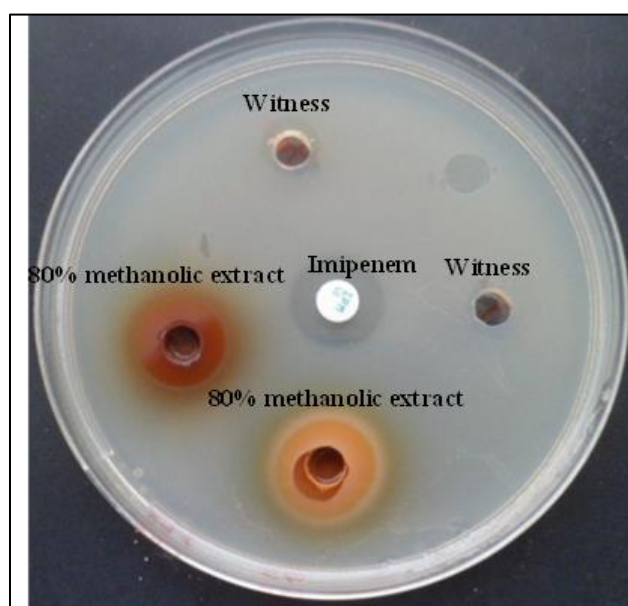


Figure 1: Antibacterial activity of the hydromethanolic extract at 50 mg/mL and an antibiotic (Imipenem) on a *Pseudomonas aeruginosa* culture.

2.4.3 Preparation of the inoculum for liquid medium tests

Young, 24-hour-old colonies were harvested and emulsified in a test tube containing 10 mL of sterile Mueller-Hinton broth. The mixture was incubated at 37°C for 3 hours. Following this incubation, a 0.3 mL aliquot of the preculture was diluted in 10 mL of sterile Mueller-Hinton broth and then homogenized.

2.4.4 Preparation of the concentration range

The concentration range was obtained using the twofold serial dilution method. To this end, a solution of the extracts at a concentration of 50 mg/mL was prepared in sterile distilled water. A series of twofold dilutions was performed starting from this solution to obtain a concentration range of 25 to 0.19 mg/mL.

2.4.5 Determination of antibacterial parameters

Antibacterial parameters were determined using the broth dilution method described by [11]. Specifically, 0.2 mL of each extract concentration was combined with 1.8 mL of bacterial inoculum in ten experimental test tubes. The growth control tube received 0.2 mL of sterile distilled water in addition to the inoculum, while the sterility control received only 2 mL of sterile Mueller-Hinton broth. This setup yielded a concentration range of 5 to 0.019 mg/mL (a tenfold dilution series). The tubes were incubated for 24 hours at 37°C. Following incubation, the lowest concentration showing no visible bacterial growth was identified as the Minimum Inhibitory Concentration (MIC). The Minimum Bactericidal Concentration (MBC) was defined as the concentration resulting in 0.01% viable bacteria after 24 hours of incubation at 37°C. Determination of the MBC began with a bacterial count; this involved serially diluting the initial inoculum (from 10^{-1} to 10^{-4}), streaking these dilutions onto Mueller-Hinton agar (MHA) in 5 cm lines using a calibrated 2 μ L loop, and incubating for 24 hours. These Petri dishes were labeled "A." After reading the MIC results, the contents of the tubes showing no visible growth were used to streak MHA plates in 5 cm lines. This series of Petri dishes is designated as series B. The MBC was determined by comparing bacterial growth between dishes in series A and series B. Thus, the lowest concentration showing fewer than 0.01% viable bacteria relative to the initial inoculum was identified as the MBC. The MBC/MIC ratio helped clarify the mode of action of the extracts [12]. According to [13], an extract is bactericidal when its MBC equals its MIC or when the MBC/MIC ratio is less than or equal to 4. It is considered bacteriostatic when the MBC/MIC ratio exceeds 4. When this ratio equals 32, the strain is classified as tolerant.

2.5 Phytochemical characterization

The various chemical compounds in the extract were identified using thin-layer chromatography (TLC) following the method described by [11]. This method allows for the detection of several groups of secondary metabolites through specific color reactions, observed either in the visible range or at a specific wavelength [14]. A 10 mg sample of the extract was dissolved in 1 mL of absolute methanol to yield a 10 mg/mL solution. Ten microliters (10 μ L) equivalent to 100 μ g of this solution were spotted onto a silica gel F₂₅₄ plate (stationary phase) using a microcapillary tube. The chromatograms were developed in tanks pre-saturated with the eluent (mobile phase) : CHCl₃-MeOH-H₂O (65:35:5 v/v/v), and subsequently dried. The plates were examined both before and after visualization, either under visible light or under a UV lamp at 254 and 366 nm. The retention factors (Rf) of the observed spots were calculated using the following formula :

$$R_f = \frac{\text{Distance traveled by the compound}}{\text{Distance traveled by the compound solvent}}$$

2.5.1 Detection of terpenoids and saponins

These compounds were detected using Godin's reagent. Following spraying of the plate with Godin's reagent and heating at 100°C for 10 minutes, the appearance of various colors was observed. In the visible range, the observation of violet and red spots indicates the presence of monoterpenes, while blue spots indicate saponins [15].

2.5.2 Detection of Alkaloids

After spraying with Dragendorff's reagent and heating the chromatogram at 100°C for 10 minutes, the alkaloids appear as orange spots under visible light.

2.5.3 Detection of Polyphenols

After spraying the chromatogram with 10% Folin-Ciocalteu reagent and heating at 100°C for 10 minutes, the blue spots observed in the visible range indicate the presence of polyphenols [16].

2.5.4 Detection of flavonoids and sesquiterpene lactones

After spraying the chromatogram with 5% (w/v) aluminum chloride (AlCl_3) and heating, the presence of flavonoids is indicated by yellow spots visible under visible light or UV light at 366 nm. As for sesquiterpene lactones, they are indicated by fluorescence of various colors at 366 nm [15].

2.5.5 Detection of Coumarins

A 5% (w/v) solution of basic lead acetate $(\text{CH}_3\text{COO})_2\text{Pb}$ was used to spray the chromatogram. Green and blue fluorescent spots under UV light at 366 nm indicate the presence of coumarins.

2.5.6 Detection of Tannins

The appearance of spots of various colors (blue, green, black) visible to the naked eye after spraying the chromatogram with a 10% FeCl_3 solution indicates the presence of tannins.

2.5.7 Detection of anthraquinones and anthrones

A 5% ethanolic KOH solution was sprayed onto the chromatogram. Red spots, visible under both visible light and at 366 nm, confirm the presence of anthraquinones. Anthrones, on the other hand, appear as yellow spots at 366 nm [17].

2.6 Statistical analysis of the results

Analysis of variance (one-way ANOVA) followed by Tukey's test was used to compare variations in MICs and MBCs among the samples and to determine whether the activity of *Ficus iteophylla* leaf extracts was statistically influenced by bacterial phenotypes. Results are expressed as means $\pm$ standard deviations. Probability values of $P < 0.05$ were considered statistically significant. R software (version 4.4.3) was used to perform these statistical tests.

3 RESULTS

3.1 Bacterial susceptibility

Leaf extract of *F. iteophylla* showed varying degrees of activity against all the bacteria studied, as evidenced by the mean inhibition zone diameters, which ranged from 18 ± 1.4 to 13 ± 2.0 mm (Table 2). This inhibitory effect was most notable regarding the *in vitro* growth of *P. aeruginosa* 795C, which exhibited the largest mean inhibition zone diameter (18 ± 1.4 mm). In other words, this strain which displays an imipenem-resistant phenotype due to a D2 porin deficiency and was isolated from the pus of a patient with a genital superinfection was the most susceptible to the hydromethanolic extract. Overall, the extract demonstrated activity against all the tested strains.

Table 2: Activity (mean $\pm$ SD) of the methanolic extract of *Ficus iteophylla* leaves at 50 mg/mL against *Pseudomonas aeruginosa* strains.

Espèces codées	Diamètres d'inhibition (mm)
<i>Pseudomonas aeruginosa</i> 891C	17 ± 0.7
<i>Pseudomonas aeruginosa</i> 489C	13 ± 2.0
<i>Pseudomonas aeruginosa</i> 261C	14.5 ± 0.3
<i>Pseudomonas aeruginosa</i> 1076C	15 ± 2.1
<i>Pseudomonas aeruginosa</i> 795C	18 ± 1.4
<i>Pseudomonas aeruginosa</i> 792C	14.5 ± 1.1
<i>Pseudomonas aeruginosa</i> 1646C	15.3 ± 1.4
<i>Pseudomonas aeruginosa</i> 956C	17 ± 1.2
<i>Pseudomonas aeruginosa</i> 955Y	16.5 ± 0.6
<i>Pseudomonas aeruginosa</i> 565C	17 ± 1.1
<i>Pseudomonas aeruginosa</i> 1016C	17 ± 2.0
<i>Pseudomonas aeruginosa</i> (ATCC 27853)	16.7 ± 0.6

3.1.1 Antibacterial parameters

The 80% (v/v) methanolic extract of *F. iteophylla* leaves yielded MIC values ranging from 0.625 to 1.25 mg/mL. The lowest value (0.625 mg/mL) was obtained for five (5) strains, comprising three resistant strains (*P. aeruginosa* 489C, 795C, and 1646C) and two wild-type strains (*P. aeruginosa* 955Y and 565C). Minimum bactericidal concentrations (MBCs) ranged from 2.5 to 10 mg/mL (**Table 3**). Furthermore, the extract demonstrated a bactericidal effect against 41.66% of the tested strains.

Table 3: Mean values (mean $\pm$ SD of three tests) of the antibacterial parameters of the 80% methanolic extract of *Ficus iteophylla* leaves on *Pseudomonas* strains

Coded species	Antibacterial parameters			
	MIC (mg/mL)	MBC (mg/mL)	$\frac{MBC}{MIC}$	Power
<i>Pseudomonas aeruginosa</i> 891C	1.25	10	8	bacteriostatic
<i>Pseudomonas aeruginosa</i> 489C	0.625	2.5	4	bactericidal
<i>Pseudomonas aeruginosa</i> 261C	1.25	5	4	bactericidal
<i>Pseudomonas aeruginosa</i> 1076C	1.25	10	8	bacteriostatic
<i>Pseudomonas aeruginosa</i> 795C	0.625	5	8	bacteriostatic
<i>Pseudomonas aeruginosa</i> 792C	1.25	10	8	bacteriostatic
<i>Pseudomonas aeruginosa</i> 1646C	0.625	5	8	bacteriostatic
<i>Pseudomonas aeruginosa</i> 956C	1.25	5	4	bactericidal
<i>Pseudomonas aeruginosa</i> 955Y	0.625	5	8	bacteriostatic
<i>Pseudomonas aeruginosa</i> 565C	0.625	5	8	bacteriostatic
<i>Pseudomonas aeruginosa</i> 1016C	1.25	5	4	bactericidal
<i>Pseudomonas aeruginosa</i> (ATCC 27853)	1.25	5	4	bactericidal

MIC : minimum inhibitory concentration ; MBC : minimum bactericidal concentration ; Bcidal : bactericidal; Bstatic: bacteriostatic.

3.1.2 Results of statistical analysis

The statistical test performed in this study allowed for a comparison of the mean values ($\pm$ standard deviations) obtained for wild-type bacterial strains (*P. aeruginosa* 955Y, 565C, and 1016C) with those of the other bacteria exhibiting a resistant phenotype. Analysis of variance showed that the differences observed in MIC and MBC values were not significant at the 0.05 level (**Table 4** ; $P > 0.05$).

Table 4: Comparison of mean values (mean $\pm$ SD of three trials) of MIC and MBC for the 80% methanolic extract according to bacterial strain phenotypes.

Antibacterial parameters	Wild-type bacterial strains	Resistant bacterial strains	p-value
MIC (mg/ml)	0.854 $\pm$ 0,6	1.021 $\pm$ 1.0	P > 0.05
MBC (mg/ml)	5.3 $\pm$ 1.3	6.652 $\pm$ 0.7	P > 0.05

3.1.3 Phytochemical screening results

Qualitative analysis revealed the presence of nine (9) groups of chemical compounds: saponins, anthraquinone glycosides, polyterpenes, polyphenols, catechin and gallic tannins, anthocyanins, flavonoids, and alkaloids, several of which are known for their antimicrobial activity (**Table 5**).

Table 5: Compounds identified by TLC in aqueous and methanolic extracts of *Ficus iteophylla* leaves.

Eluent: Chloroform/methanol/water (65:35:5) ; Support : Silica gel 60 F₂₅₄									
Extract		Before revelation	After revelation						Possible chemical compounds
			Godin	Drogen-dorff	Folin-Ciocalteu	AlCl ₃	FeCl ₃	KOH	
Methanolic	Head-on collision	0.67	0.88		0.88 0.52	0.52 0.25	0.25	0.52	Saponins, polyterpenes, polyphenols, catechin and gallic tannins, anthraquinone glycosides, anthocyanins, alkaloids, flavonoids.
	Color	blue	purple	Orange	Blue Blue	Yellow Yellow	Noir	Yellow	

4 DISCUSSION

4.1 Inhibition dynamics and vulnerability of multidrug-resistant strains

In vitro evaluation of the *Ficus iteophylla* leaf extract reveals a remarkable spectrum of antibacterial activity against a panel of twelve (12) *Pseudomonas aeruginosa* strains. Isolate susceptibility was reflected in a clear variation in inhibition zone diameters. According to the criteria established by [18], a crude plant extract is considered active if it produces an inhibition zone of 10 mm or greater. The extract under study significantly exceeded this threshold for all tested strains. This activity was most pronounced against the clinical strain *P. aeruginosa* 795C ; at a concentration of 50 mg/mL, the extract produced an inhibition zone diameter of 18 ± 1.4 mm. The clinical significance of this result lies in the fact that this bacterium isolated from a genital superinfection exhibits a critical resistance phenotype to imipenem, driven by a deficiency in OprD2 porins [6]. These findings highlight the efficacy of *F. iteophylla*, suggesting concrete alternative therapeutic prospects and scientifically validating the empirical use previously documented by [19].

4.2 Quantitative parameters (MIC/MBC) and mechanisms for overcoming resistance

Quantitatively, the lowest Minimum Inhibitory Concentration (MIC) recorded was 0.625 mg/mL. This susceptibility threshold was observed in five (5) strains, comprising three multidrug-resistant isolates (489C, 795C, 1646C) and two wild-type strains (955Y, 565C). Statistical analysis indicates that variations in MIC and MBC values across the different strains are not significant, highlighting a similarity in overall activity. The extract thus demonstrates consistent efficacy, regardless of the bacteria's acquired or intrinsic resistance profiles. This finding suggests that the active principles within the hydromethanolic extract utilize entry pathways or molecular targets distinct from those of conventional antibiotics. Mechanisms such as D2 porin deficiency or the hyperproduction of cephalosporinases which typically neutralize beta-lactams prove ineffective at blocking the extract's action. The inherent chemical complexity of the plant matrix allows it to overcome bacterial membrane impermeability; this corroborates the conclusions of [6] regarding the potent bactericidal and bacteriostatic properties of *F. iteophylla* bark and leaves.

4.3 Phytochemical profile and targeted pharmaco-chemical mechanisms

Phytochemical screening revealed nine (9) major groups of secondary metabolites (saponins, polyterpenes, polyphenols, catechin and gallic tannins, anthocyanins, and flavonoids). The antibacterial activity is not attributable to a single isolated compound but rather stems from a multi-target molecular synergy in which each chemical family plays a complementary role. Flavonoids and polyphenols, rich in phenolic groups, are capable of complexing with structural proteins and inhibiting vital bacterial enzymes, thereby disrupting fundamental metabolic balances [20]. Saponins and polyterpenes possess surfactant and lipophilic properties; they act as agents of mechanical perforation and destabilize the lipid bilayer of the *P. aeruginosa* outer membrane. As for the tannins (gallic and catechich), they are recognized for their antiseptic and astringent properties [21], enabling them to exploit the membrane breaches created by saponins to infiltrate the cytoplasm en masse. There, they precipitate vital proteins and block bacterial DNA replication. Subjected to this simultaneous, multifaceted assault, the pathogen is unable to activate its usual detoxification systems. This dual mechanical and biochemical blockade firmly substantiates the prominent role of *F. iteophylla* in the traditional African pharmacopoeia for managing microbial infections [22].

4.4 Therapeutic prospects and ecological role

Beyond its purely clinical value, *F. iteophylla* occupies a pivotal position at the intersection of human health and environmental balance. In tropical and subtropical regions, this species plays a central ecological role, particularly through its figs, which constitute an essential food source for local wildlife. However, the public's enthusiasm for its numerous therapeutic virtues frequently leads to overexploitation that could jeopardize ecosystem stability [6].

Furthermore, from a medical perspective, the identification of a wide range of secondary metabolites in the plant paves the way for innovative approaches, such as combination therapy. Combining the hydromethanolic extract of *F. iteophylla* with conventional antibiotics (such as imipenem) warrants exploration. Such synergy could restore the susceptibility of multidrug-resistant clinical strains, potentiate the activity of conventional molecules, and reduce effective therapeutic doses, thereby limiting the emergence of new resistance.

5 CONCLUSION

This study provides scientific evidence of the remarkable antibacterial activity of *F. iteophylla* leaves against various strains of *Pseudomonas aeruginosa*. Rigorous assessment of minimum inhibitory concentrations (MIC) and minimum bactericidal concentrations (MBC) demonstrates the potent bactericidal activity of the 80% (v/v) methanolic extract, thereby confirming its potential therapeutic efficacy. Furthermore, phytochemical screening revealed major groups of secondary metabolites whose synergistic action likely underpins this antimicrobial property. These promising results pave the way for several essential avenues of research: further ethnopharmacological studies to contextualize and leverage traditional knowledge; *in vivo* biological validation to confirm the extract's efficacy within a living organism; and safety and toxicity assessments to ensure the plant can be used safely.

F. iteophylla stands as a promising future therapeutic alternative and a potential source of new anti-infective agents, offering tangible hope in addressing the major public health challenge posed by bacterial resistance.

STATEMENTS ON COMPLIANCE WITH ETHICAL STANDARDS

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Disclosure of conflict of interest

The authors declare no conflict of interest.

Author contributions

This work was carried out in collaboration with all the listed authors. They participated in all stages of the manuscript's development, up to the final version. They have read and approved the final manuscript.

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